CDF note 8724

First Measurement of $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$

The CDF Collaboration
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We present the first measurement of $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$. We use the low p_T track multiplicity in lepton+jet channel to separate out gg initial states. We show that the average number of low p_T tracks scales with the gluon content of the sample. We take advantage of the fact that the gluon composition of the gluon rich fraction of the Standard Model $t\bar{t}$ processes is close to that of the gluon-rich fraction of dijet samples with relatively high leading jet E_T values, and that the W+0 jet sample is dominated by $q\bar{q}$ initial states. We extract the gluon rich fraction and measure $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$. We find a value of 0.01±0.16(stat)±0.07(syst) for $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$ using 0.95 fb^{-1} of data.

Preliminary Results for Winter 2007 Conferences

I. INTRODUCTION

According to the standard model(SM) in ppbar collisions of center-of-momentum of about 2 TeV, top quark pairs are expected to be produced through gluon gluon fusion (15%) and quark-antiquark annihilation (85%) [1]. In this study, we make a measurement of the $t\bar{t}$ cross section fraction through gg fusion. This can provide a test of the perturbative Quantum Chromo Dynamics(pQCD). Also, it may reveal the existance of unknown $t\bar{t}$ production and top quark decay mechanisms, where the new decay mechanism denies the excess due to new production mechanism over the SM prediction [2]. Thus, there is an interest in studying the ttbar production mechanisms independent of the ttbar final state channels.

In order to make this measurement, one needs to discriminate between the two production channel. In this study, we take advantage of the fact that gluons are more likely to radiate a gluon with a low fraction of their momentum than quarks, as such we expect to see larger number of low energy particles in gg than in $q\bar{q}$ production channel. To be able to observe this difference, we use the low p_T charged particle multiplicity. The CDF detector is described in detail in [3]. As there are large uncertainties associated with the Monte Carlo (MC) prediction for the soft gluon radiation, we cannot rely on MC for this analysis and so define a number of calibration samples that are similar to the gg and $q\bar{q}$ processes.

II. DATA SAMPLE & EVENT SELECTION

This analysis is based on an integrated luminosity of 0.95 fb^{-1} collected with the CDF II detector between March 2002 and February 2006. We use both data and MC samples for dijet and W+n jet processes as explained in the following subsections. These samples have different gluon contents based on their leading jet E_T range or jet multiplicity, respectively. The MC samples are used to find the average number of gluons present in each sample while data samples are used to find the average number of charged particles in a sample.

A. W+n Jet Samples

The W+n jet data are collected with an inclusive lepton trigger that requires an electron or muon with E_T >18 GeV (P_T >18 GeV/c for the muon). From this inclusive lepton dataset we select events offline with a reconstructed isolated electron E_T (muon P_T) greater than 20 GeV, missing E_T >20 GeV. Jets have E_T >15 GeV. W+n jet samples where n = 0, 1, 2, or 3 constitute part of our calibration sample. As this sample has large background coming from QCD interactions, if the $\not\!\!E_T$ is less than 30 GeV, we require $\Delta\phi$ between the leading jet and the $\not\!\!E_T$ to be between 0.5 to 2.5 rad. We remove any event that is a $t\bar{t}$ dilepton or a Z boson candidates and veto any event where the electron is consistent with coming from a conversion. The MC sample used for the W+n jet is ALPGEN+PYTHIA for W($\rightarrow e/\mu\nu$) + 0, 1, 2, 3 and 4 partons, where each sample is added with the appropriate weight based on their cros sections. The same event selection criteria is applied to both data and MC. Jets are defined using a cone algorithm with a cone of 0.4 and are corrected for energy calibration, calorimeter η dependence and multiple interactions.

B. Dijet Samples

The dijet data are collected using two inclusive jet triggers that require a jet with E_T of 50 and 100 GeV. The MC samples are generated using PYTHIA [4] with minimum p_T of 40 and 90 GeV tuned to reproduce the underlying events. For both data and MC, following event selection criteria is used.

- To avoid any trigger bias, we require a minimum uncorrected leading jet E_T of 75 and 130 GeV for Jet50 data (Jet40 MC) and Jet100 data (Jet90 MC), respectively.
- We remove any event that has any electron or muon with E_T >18 GeV (P_T >18 GeV/c for the muon).
- We require 2 and only 2 jets within $|\eta| \leq 2$ with a minimum corrected E_T of 20 GeV in the event.
- The two jets should be back-to-back in ϕ within 35^o.

Jets are defined the same way as in W+n jet except that they are also corrected for any non-linearity and energy loss in the un-instrumented regions of the calorimeter.

C. $t\bar{t}$ Candidates

To define $t\bar{t}$ candidates, we look at the W+4 or more jet bin. This sample has a noticeable background coming from the W boson production in association with jets, to reduce this background, we require at least one of the jets in the event to be identified as coming from a b-quark (b-tagged) jet. Our selection criteria for $t\bar{t}$ candidates is similar to the standard $t\bar{t}$ cross section measurements. Jets are defined the same way they are defined in the W + n jet sample.

III. TRACK MULTIPLICITY

We would like to show that there is a correlation between number of gluons and number of low p_T tracks in a given sample. We find the average number of low p_T tracks, $< N_{trk} >$, using data and the average number of gluons in the sample, $< N_g >$, using MC as explained in the following subsections.

A. Track Selection

In this section, we describe the selection criteria for including a track in our definition of track multiplicity. The goal is to have a track multiplicity that best represents the presence of the soft gluons radiated from the "matrix element" partons in the event and therefore it should be independent of the number of extra interactions and number of jets present in the event. One would also like to reduce the contribution from the final state partons. These are explained in more detail in the following.

- We use tracks with p_T in the range 0.3-2.9 GeV/c and $|\eta| \leq 1.1$, where we expect to have good tracking coverage.
- The tracks should not be part of the jets present in the event. We therefore require the tracks not to fall within $\Delta R = 0.6$ of the high E_T jets (15 GeV or more) and within $\Delta R = 0.4$ of the low E_T (6-15 GeV) jets in the event. These cuts are set as such due to the fact that we expect higher E_T jets to generate larger number of wide-angle, low p_T particles than low E_T ones.
- The track should match the primary vertex of the event within ± 3 cm. This requirement reduces the contribution from other interations.
- We also check that the track will not match a second vertex better than it does match the primary vertex.
- The fact that we exclude regions around the jets provides different tracking area available for different events and samples. To have a comparable track multiplicity, we find the track density for each event by dividing the track multiplicity by the available tracking area. Then, we multiply this density with the total central area, 4.4π, to get our tracking multiplicity.
- The track multiplicity, even though tracks from jets are excluded, still has a dependency on the number of high E_T jets in the event. We, therefore, have some further correction due to contribution from each high E_T jet present in the central ($|\eta| \leq 1.1$) region.

For both W + n jet and dijet samples, the jets used here for the track counting procedure are defined as the jets in dijet sample.

B. Counting Gluons

We apply the same event selection cuts as data to MC samples. Then using the generator-level information, we count the number of gluons in each event, taking into consideration the 2 incoming and all the outgoing partons. We define the outgoing partons as the immediate daughters of the 2 incoming partons. For all dijet samples, we have 2 incoming and 2 outgoing partons. In the W samples, depending on the type of generated event, we have 2 incoming and 0, 1, 2, 3 or 4 (excluding the W boson) outgoing partons corresponding to the W+0, 1, 2, 3 or 4 parton samples used to create the W+njet MC sample. To get the average number of gluons in a sample, we sum over the number of gluons in each event of our MC sample and divide the sum by the total number of events in the sample.

C. $< N_{trk} >$-$< N_g >$ Correlation

The correlation between $< N_{trk} >$ (measured from data) and $< N_g >$ (MC calculations) as well as the linear χ^2 fit to W+0, 1 and 2 jet samples along with the dijet samples with leading jet E_T range 80-100, 100-120 and 120-140 GeV are shown in Fig. 1. This correlation can be used to measure $< N_g >$ in a given data sample. The comparisons of the measured and the expected $< N_g >$ are shown in Table I.

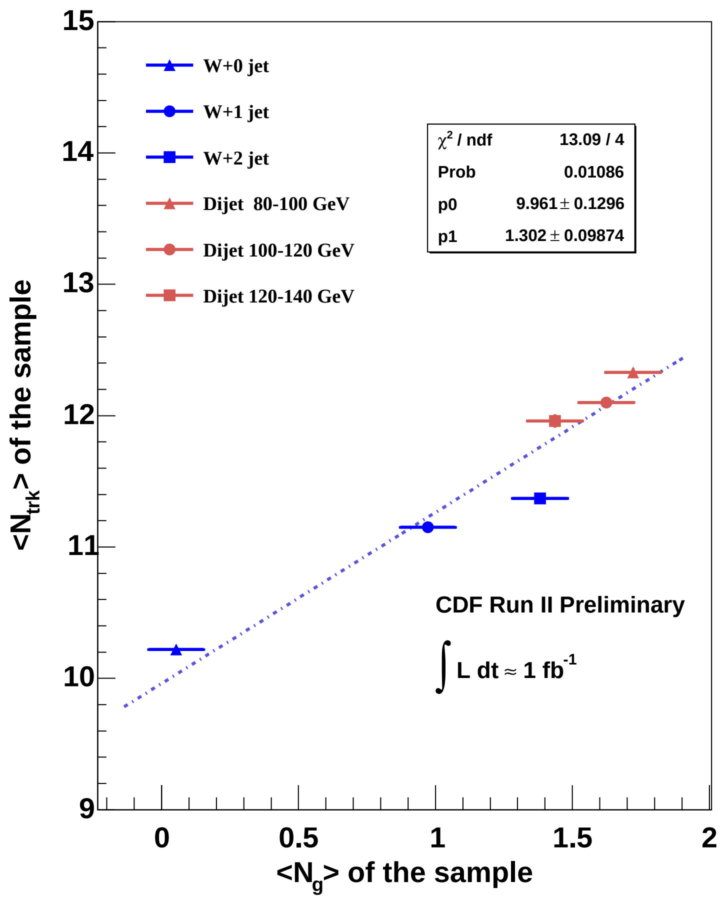

FIG. 1: Using three W and three dijet samples, we find the correlation between the average low p_T track multiplicity and the average number of gluons. $< N_g >$ is predicted using MC for each sample and $< N_{trk} >$ is measured using data. Different samples are shown with different markers and colors. The lighter grey(red) corresponds to dijet samples and the darker grey(blue) represents W samples. Solid circles, squares and triangles are used to distinguish different subsamples as specified in the legend.

IV. MEASUREMENT METHOD

The $< N_{trk} >$ and $< N_g >$ correlation enables us to define low p_T track multiplicity distributions representing specific average number of gluons. Most importantly, we can define gluon rich distributions and distributions with no gluon content. The latter can be defined using the W+0 jet data sample. This sample is almost purely a quark-quark process with a small QCD background of order 1%. It also includes some gluon content coming from W production in association with other partons when we fail to observe these partons in form of jets, (we call this the "feed-down background"). We use MC calculations to predict the composition of this background and alternatively

Sample	MC expectation	from fit to data
dijet 140-160 GeV	1.26 ± 0.04	$1.41^{+0.07}_{-0.04}$
dijet 160-180 GeV	1.13 ± 0.04	$1.25^{+0.06}_{-0.05}$
dijet 180-200 GeV	0.99 ± 0.07	$1.11^{+0.05}_{-0.06}$
dijet 200-220 GeV	0.92 ± 0.10	$0.91^{+0.04}_{-0.08}$
dijet 220+ GeV	0.67 ± 0.10	$0.68^{+0.04}_{-0.10}$

TABLE I: The average number of gluons in each sample as predicted by MC calculations and the average number of gluons as found using the correlation fit for data. All uncertainties are statistical.

its contribution to the average number of gluons present in the W+0 jet sample. To define the gluon rich distribution, we use our dijet sample with the lowest jet E_T range, 80-100 GeV. In order to have as pure as possible no-gluon distribution and a gluon rich distribution with a comparable gluon content to that of the $t\bar{t}$, we iteratively subtract the gluon component from W+0 jet sample and $qq \rightarrow qq$ contribution from the dijet sample with a leading jet E_T of 80-100 GeV. The $qq \rightarrow qq$ is estimated to be about 27% using PYTHIA MC calculations. We first normalize the W+0 jet sample to our dijet sample and then subtract it from the dijet sample by a factor of 0.27. This will give us the first gluon rich sample. We then use this subtracted, gluon rich sample to subtract the gluon content contribution to the W+0 jet distribution. We have an $< N_g >$ estimate of 0.07 for the W+0 jet sample, where about 0.05 is the feeddown background contribution and about 0.02 is the QCD background contribution, as we have less than 1% QCD background and we assume it has a similar gluon content as that of the gluon rich sample. Using the estimated gluon composition of the dijet sample, from PYTHIA MC calculations, we then subtract the gluon content of the W+0 jet. This subtracted version of the W+0 jet sample is what we consider as our no gluon distribution. Finally, we subtract the $qq \rightarrow qq$ contribution from dijet 80-100 GeV track multiplicity distribution using our no gluon distribution, normalized and scaled to the appropriate fraction of 27%. The remaining distribution is what we consider our gluon rich sample. Changes to the distributions due to subsequent iterations are indistigushable. We use the normalized parameterizations of these distributions in a simple binned likelihood fit with two free parameters to find the fraction of gluon rich components in a given sample. Figure 2 shows the parameterizations of the no gluon and gluon rich distributions. The gluon rich fraction of a given low p_T track multiplicity distribution can be found using the following fit

$$N[f_g \mathcal{F}_g + (1 - f_g)\mathcal{F}_q] \tag{1}$$

where, N is the normalization factor and one of the free parameters, f_g is the fraction of gluon rich components of the sample and the other free parameter and $\mathcal{F}_g$ and $\mathcal{F}_q$ are the normalized gluon rich and 0-gluon parameterizations, respectively.
The fraction f_g can be used as the fraction of gluon rich components for samples with similar gluon compisition or can be used to find the $< N_g >$ in a given sample by multiplying it with the estimated $< N_g >$ in the gluon rich distribution, ~ 2.36, based on its gluon composition. Table II summarizes the f_g measured using the fit to the dijet data calibration sample distributions and estimated f_g from MC calculations. The good agreement between the fit values allows us to move to the next step, which is to extract the gluon-rich fraction of the $t\bar{t}$ sample and measuring $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$.

A. $t\bar{t}$ Gluon Rich Fraction

The measured gluon rich fraction in the tagged W+4 or more jet sample, consists of two components, the $t\bar{t}$ gluon rich fraction and the background gluon rich fraction. Therefore, knowing the background fraction in our sample and the measured f_g from the fit, we can write

$$f_g = f_b f_g^{bkg} + (1 - f_b) f_g^{t\bar{t}}, \tag{2}$$

where, f_b is the background fraction and f_g^{bkg} and $f_g^{t\bar{t}}$ are the gluon rich fraction of the background and $t\bar{t}$ signal, respectively. The latter is what we want to measure, while f_b can be estimated for the 4 or more jets tagged sample

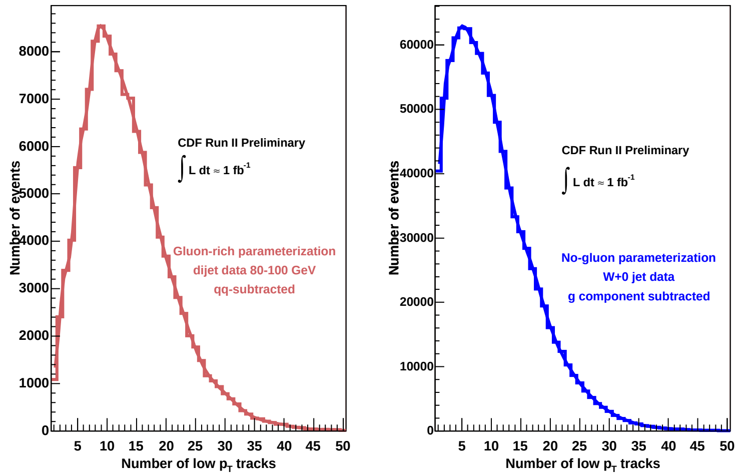

FIG. 2: The plot on the left shows a comparison between the dijet data sample with jet E_T range 80-100 GeV and the final parameterization. The plot on the right shows a similar comparison between W+0 jet data sample and the final parameterization.

Sample	MC expectation	f_g from fit to data
dijet 80-100 GeV	0.73 ± 0.03	0.73 ± 0.01
dijet 100-120 GeV	0.69 ± 0.03	0.69 ± 0.01
dijet 120-140 GeV	0.63 ± 0.04	0.65 ± 0.01
dijet 140-160 GeV	0.57 ± 0.04	0.62 ± 0.01
dijet 160-180 GeV	0.52 ± 0.04	0.56 ± 0.01
dijet 180+ GeV	0.42 ± 0.05	0.48 ± 0.01

TABLE II: The fraction of gluon-rich events in each sample as predicted by MC calculations and the fraction of gluon-rich events as found using the likelihood fit to track multiplicity distributions. All data and fitted uncertainties are statistical. Uncertainties for the MC fractions are statistical and systematical.

as done for $t\bar{t}$ cross section measurements. Figure 3 shows the fit to the tagged W+4 or more jets sample. We need to find the fraction of gluon rich components in the background. In order to do so, We measure f_g in W+1, W+2 and W+3 jet data samples with no positive SecVtx tag and with at least one tight SecVtx b-tag using the likelihood fit. We then extrapolate the f_g values from W+1, 2 and 3 jet to W+4 or more jet bins for both tagged, ${f_g^{bkg}}^{Tagged}$, and no-tag, ${f_g^{bkg}}^{Notag}$, samples. We consider the tagged sample as the representative for the single top and heavy flavour backgrounds, and the no-tag sample as the representative of the light flavour background. As nonW background consists of both HF and LF events, we consider half of this background to contribute to HF and half to the LF background. Therefore, one can get an estimate of f_g^{bkg} by adding ${f_g^{bkg}}^{Tagged}$ and ${f_g^{bkg}}^{Notag}$ weighted by the corresponding background fractions, f_{bkg}^{HF} and f_{bkg}^{LF}. As manifested by the following equation

$$f_g^{bkg} = {f_g^{bkg}}^{Notag} f_{bkg}^{LF} + {f_g^{bkg}}^{Tagged} f_{bkg}^{HF}. \quad (3)$$

We determine the f_g^{bkg} uncertainty assuming Gaussian distributions for the four variables used to define f_g^{bkg} and then numerically calculating a distribution for f_g^{bkg}. Using this distribution, we find a value of 0.58 ± 0.08 for the gluon-rich fraction of the background. The gluon fractions found by the fit for W+1, 2 and 3 jet in both tagged and no-tag samples, as well as the extrapolated values are shown in Table III. The gluon-rich fraction in the no-tag sample increases with increasing jet multiplicity. The tagged sample has contributions from $t\bar{t}$ in 2 and 3 jet bin and as such, assuming SM prediction for $t\bar{t}$, one would expect the actual gluon-rich fraction to be different from what we observe if we take into account the contribution from $t\bar{t}$. To correct for this, one needs to know $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$. As this is the variable we measure and given the small contribution of tagged f_g to the calculation of $f_g^{t\bar{t}}$, 0.45 HF fraction of 0.13 f_b, we use the observed fractions with no correction.

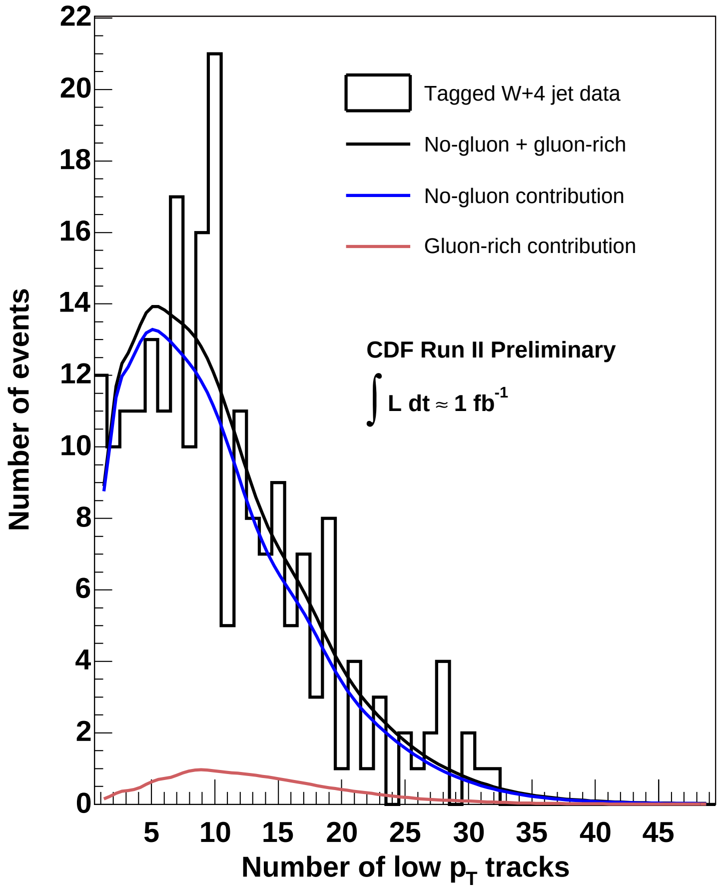

FIG. 3: The fit result for the tagged W+4 or more jet sample. The two components of the fit (gluon rich and 0-gluon) contributions are also shown.

Jet multiplicity	No b-tag	At least 1 b-tag
W+1 jet	0.37 ± 0.01	0.55 ± 0.06
W+2 jet	0.48 ± 0.02	0.34 ± 0.09
W+3 jet	0.50 ± 0.05	0.28 ± 0.13
Extrapolated W+4 or more jets	0.70 ± 0.05	0.00 ± 0.22

TABLE III: gluon-rich fraction values from the likelihood fit to the low p_T track multiplicity distributions for W+0, 1 and 2 jet samples with no positive b-tag and with at least one positive b-tag, as well as the extrapolated gluon-rich fractions for both tagged and no-tag sets.

We use the $t\bar{t}$ cross section measurement [5] estimates to get the background event fraction as well as the HF and LF fractions. The background fractions used in the analysis, f_b, f_{bkg}^{HF} and f_{bkg}^{LF} in the tagged sample, are summarized in Table IV. Using $f_b = 0.13$, $f_g^{bkg} = 0.46$ and measured $f_g = 0.07 \pm 0.15$, we get $f_g^{t\bar{t}} = 0.01 \pm 0.18$. The systematics uncertainties will be discussed later on.

	Tagged W+4 or more jet sample
HF/bkg	0.45 ± 0.11
LF/bkg	0.55 ± 0.13
bkg/S+bkg	0.13 ± 0.02

TABLE IV: The background fractions used in the analysis, f_b, f_{bkg}^{HF} and f_{bkg}^{LF} in the tagged sample

B. $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$

The last step to measure $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$ is to estimate the relative acceptance of $gg \to t\bar{t}$ and $p\bar{p} \to t\bar{t}$. To do so, we use HERWIG MC calculations. We use about 4M $t\bar{t}$ events of which about 50K gg fusion and about 800K $q\bar{q}$ annihilation events are decayed semileptonically. The fraction of $gg \to t\bar{t}$ events that falls in 4 or more jet bins is higher than that of the $q\bar{q} \to t\bar{t}$, as expected due to higher gluon radiation probability for gluons. Using the MC calculations, we find $(9.9 \pm 0.2(stat + syst))\%$ of $gg \to t\bar{t}$ and $(8.8 \pm 0.2(stat + syst))\%$ of $p\bar{p} \to t\bar{t}$ events passing our tagged sample criteria. These numbers do not have the b-tag SF incorporated in them. As we are interested in the relative acceptance, the effects of this factor cancel out. We find

$$\frac{\sigma(gg \to t\bar{t})}{\sigma(p\bar{p} \to t\bar{t})} = \frac{1}{1 - (\mathcal{A}_{gg\to t\bar{t}}/\mathcal{A}_{q\bar{q}\to t\bar{t}}) + (\mathcal{A}_{gg\to t\bar{t}}/\mathcal{A}_{q\bar{q}\to t\bar{t}})(1/f_g^{t\bar{t}})} = 0.01 \pm 0.16(\text{stat}), \tag{4}$$

where $\mathcal{A}_{gg\to t\bar{t}}$ and $\mathcal{A}_{p\bar{p}\to t\bar{t}}$ are the acceptance for $gg \to t\bar{t}$ and $q\bar{q} \to t\bar{t}$, respectively.

V. SYSTEMATIC UNCERTAINTIES

The systematic uncertainties of this measurement are estimated in a few steps. First, we identify and find the uncertainties affecting the track multiplity distributions. The estimates, in principal, are done by changing the central values and observing the changes in the relevant variables. Second, we find the uncertainties for the measured gluon-rich fraction and the background gluon-rich fraction estimates due to these sources as well as background composition specifically nonW association to HF or LF backgrounds. We then, use these uncertainties and the background fraction uncertainties to find the uncertainty in the $t\bar{t}$ gluon-rich fraction. At the end, we use $f_g^{t\bar{t}}$, $\mathcal{A}_{gg\to t\bar{t}}$ and $\mathcal{A}_{q\bar{q}\to t\bar{t}}$ systematic uncertainties to find the uncertanty in $\frac{\sigma(gg\to t\bar{t})}{\sigma(p\bar{p}\to t\bar{t})}$.

A. Sources of Uncertainy in Track Multiplicity Distribution

- The process composition of W+0 jet and dijets with E_T of 80-100 GeV

  We have used ALPGEN+PYTHIA and PYTHIA jet40 MC calculations for the process composition of W+0 jet and dijet events with E_T of 80-100 GeV samples, respectively. We also had the Gen5 MADGRAPH+PYTHIA (with $\mathrm{K_T}$ = 15) estimates for the W+0 jet sample. We have used a central value of 0.27 ± 0.03 for the $qq \to qq$ process in dijet 80-100 GeV and 0.07 ± 0.1 for $< N_g >$ of W+0 jet sample. To find the systematic uncertainties due to this quark gluon compositions used in the definition of gluon-rich and no-gluon distributions, we fluctuated the central values by one standard diviation. Please note that this translates to an $< N_g >$ of 0.0 and 0.17 for the W+0 jet, as a negative value is not physical.

- The choice of jet E_T threshold

  One expects higher number of jets coming from initial or final state gluon radiation in events with higher gluon content. As we exclude the low p_T tracks that fall within a radius of 0.4 from the centroid of low E_T jets (6-15 GeV), our low p_T track multiplicity distribution might change differently for the gluon-rich and no-gluon events. To estimate the effect of this cut, we measure f_g and estimate f_g^{bkg} using a low E_T cut of 8 GeV instead of 6 GeV.

- The track multiplicity correction per high E_T jet

  To reduce contributions to $< N_{trk} >$ from the high E_T jets present in the event, we make additional

	f_g	f_g^{bkg}
trk/jet	± 0.051	± 0.001
jet E_T cut	± 0.021	± 0.035
dijet $qq \to qq$	± 0.002	± 0.019
W+0 jet $< N_g >$	± 0.036	± 0.001
nonW variation	-	± 0.06
Modeling the distribution	-	± 0.08
Total	± 0.06	± 0.11
	f_g^{tt}	
f_g	± 0.08	
f_g^{bkg}	± 0.02	
f_b	± 0.01	
Total	± 0.08	
	$\frac{\sigma(gg \to tt)}{\sigma(p\bar{p} \to tt)}$	
f_g^{tt}	± 0.07	
$\mathcal{A}_{gg \to t\bar{t}}$	± 0.0003	
$\mathcal{A}_{p\bar{p} \to t\bar{t}}$	± 0.0003	
Total	± 0.07	

TABLE V: Sources of systematics effects and their effects on different variables

corrections of 0.90 ± 0.03, 0.97 ± 0.04 and 0.96 ± 0.04 to the track multiplicty of the event for each central high E_T jet in 0d, 0h and 0i datasets, respectively. We estimate the systematics associated with this correction by making the correction of $\pm 1\sigma$ of the central value for each datasets before combining them.

B. Other Uncertainies

- The estimation of f_g^{bkg}

  As mentioned in Section 3, we estimate this value by extrapolation in the no tag and tagged samples weighted by the HF and LF background fractions. Therefore, the sources mentioned above change the estimate of f_g^{bkg}. The systematic uncertainty associated with this variable is the root-square sum of uncertainty in the central value, half of the difference in the values we get if we assign all nonW background to LF or to HF backgrounds and half of the difference of the low and high values of each of the above uncertainties, except for the low jet E_T cut. In the latter, we take the difference instead of half of the difference.

- The acceptance for $t\bar{t}$ events

  We associate a systematics uncertainty of 3% for the acceptance due to the parton distribution function (PDF) and MC generator differences. This value is based on the uncertainties due to PDF (2%) and choice of MC generator (2%) in $t\bar{t}$ production cross section measurement reported in CDF note 8107 [6].

- The pseudo-experiments

  Previously, we had assigned an extra 5% systematic uncertainty to f_g due to the differences between true and measured fractions using pseudo-experiments. The differences arose from a bug in the random number generator. The bug is now fixed, and as such we do not require this uncertainty any more. Figure 4 shows the average measured f_g as a function of true f_g for 1000 pseudo-experiments.

The systematics uncertainties associated are summarized in Table V.
Taking into account these systematics effects, we find

- $f_g = 0.07 \pm 0.15(stat) \pm 0.07(syst)$,
- $f_g^{bkg} = 0.46 \pm 0.11(stat + syst)$,
- $f_g^{t\bar{t}} = 0.01 \pm 0.18(stat) \pm 0.08(syst)$,
- $\mathcal{A}_{gg \to t\bar{t}} = 0.099 \pm 0.002(stat + syst)$,

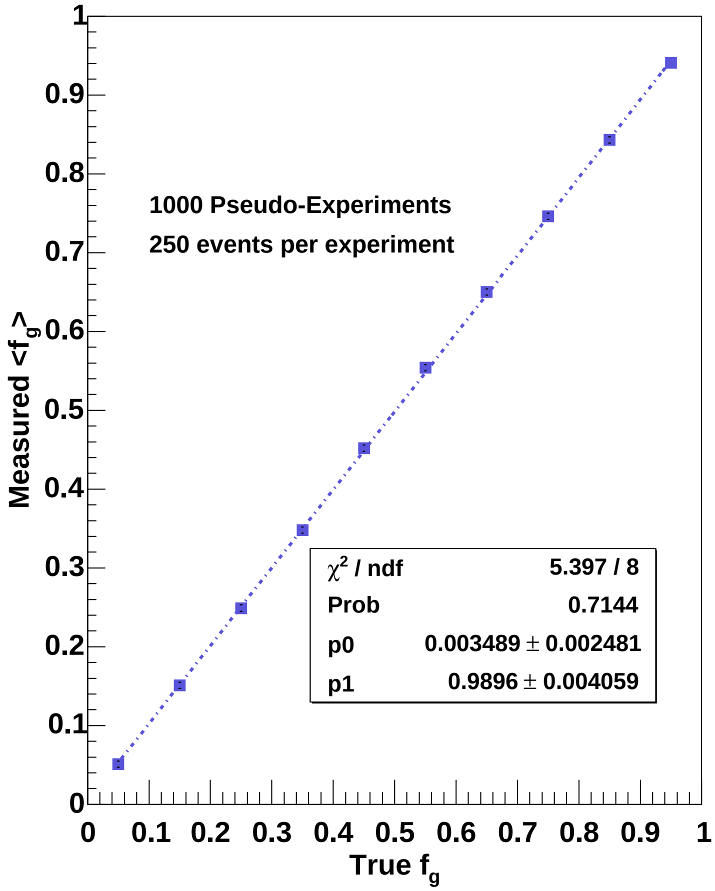

FIG. 4: The average measured f_g as a function of true f_g for 1000 pseudo-experiments.

- $\mathcal{A}_{q\bar{q}\to t\bar{t}} = 0.088 \pm 0.002(stat + syst)$

and then determine

$$\frac{\sigma(gg \to t\bar{t})}{\sigma(p\bar{p} \to t\bar{t})} = \frac{1}{1 - (\mathcal{A}_{gg\to t\bar{t}}/\mathcal{A}_{q\bar{q}\to t\bar{t}}) + (\mathcal{A}_{gg\to t\bar{t}}/\mathcal{A}_{q\bar{q}\to t\bar{t}})(1/f_g^{t\bar{t}})} = 0.01 \pm 0.16(\text{stat}) \pm 0.07(\text{syst}). \quad (5)$$

VI. CONCLUSION

The first measurement of $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$ is presented. We have used an integrated luminosity of 0.95 fb^{-1}. We have shown that the low p_T track multiplicity distribution in a given sample can be used to find the gluon composition of the sample. As there is no reliable MC calculations to predict the low p_T track multiplicity of a sample, we employe a data-driven method and define the shape of the low p_T track multiplicity distributions for 0-gluon process and gluon rich process. These parameterizations are used to find the fraction of $gg \to t\bar{t}$. Using this fraction we find a value of $0.01 \pm 0.16(\text{stat}) \pm 0.07(\text{syst})$ for $\sigma(gg \to t\bar{t})/\sigma(p\bar{p} \to t\bar{t})$. MC calculations are used to predict the composition of a given process. Sources of sustematic effects are explained and their estimated uncertainties are given.

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